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ELECTRICAL DEPARTMENT
ADMIRALTY ENGINEERING
LABORATORY
WEST DRAYTON, MIDDLESEX

THIN-PANELLED GLASS-FIBRE/RESIN CONTAINER MADE BY
PERMALI LTD. FOR SUBMARINE CELL TYPE
8000 - SHOCK.

REVISIONS OF 27/1/65

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ELECTRICAL DEPARTMENT,
ADMIRALTY ENGINEERING LABORATORY,
WEST DRAYTON, MIDDLESEX.

THIN-PANELLED GLASS-FIBRE/RESIN CONTAINER MADE BY PERMALI LTD.
FOR SUBMARINE CELL TYPE 8000 - SHOCK.

Investigator:-

R.J.L. Lewery

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SUMMARY

A second experimental thin-panelled homogeneous glass-fibre/resin container made by Pernali Ltd., for cell Type 8000 has been subjected to shock test, the first container having failed. The shock resistance of the second container was satisfactory and the bulge of its side panel was less than that of the first.

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1. INTRODUCTION

A further experimental thin-panelled container for cell Type 8000 was made by Pormali Ltd., and this report gives the results of the shock test carried out on it at the Laboratory in July 1962.

The particulars of the container were as follows:-

TABLE 1

Markings		X292	2-62	P002
Overall	Height	39	23/32	in.
	Length	21	5/32	"
	Width	13	27/64	"
Interior	Height	38	21/32	"
	Length	20	3/32	"
	Width	12	19/64	"
Thickness of Panels.	Top	0.1	" Dimensions	
	Middle	0.11	" Supplied by	
	Bottom	0.125	" manufacturers.	
Weight (without lining)		46½ lb		
Distance of centre line of horizontal ribs from base.	Rib No.2	9	5/16	"
	" " 3	19	25/32	"
Greatest width of horizontal ribs.	Rib No.1	1½ in. (1½ in. over chamfers)		
	" " 2	1⅝ in. (2 5/16 " "		
	" " 3	1¼ in. (2 in. over chamfers)		
	" " 4	1½ in. (1⅞ in. over chamfers)		
Width of corner ribs " " centre vertical ribs.		1½ in. (2 in. over chamfers)		
		1 in. (1⅞ in. over chamfers)		

(a) The parts of the container were identified as shown in Fig. 1. Marks were made on each side at the intersection of the centre lines of horizontal ribs Nos. 2 and 3 and the centre vertical rib, and the gaps between these marks and a straight edge laid horizontally across the container sides were measured before assembly.

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to provide data from which the bulge was determined at the stages of the investigation stated in Section 5. After the shock test the centre vertical ribs were proud of the corner ribs and measurements were therefore taken of the gaps between the straight-edge and the corner ribs.

(b) The exterior and interior surfaces were examined, no damage was observed but there was resin richness over about 40% of the chamfers of the horizontal ribs 2 and 3 and over parts of the centre vertical ribs of the long sides. There were also narrow areas on the exterior and interior surfaces, mostly along the boundaries of the panels, where the surface appeared white due to incomplete covering of the surface fibres by resin.

4. SHOCK TEST

The container was assembled with an element Type 8000 and a glass-fibre/resin cover Cat. No. X283 as a cell and filled to normal electrolyte level with water. For the shock test it was placed on a solid teak baseboard $1\frac{1}{2}$ in. thick and mounted on the upward blow shock machine. A series of blows was applied to the cell, commencing at a height of 2 ft 6 in. and increasing by 6 in. steps to 4 ft 6 in. The exterior of the container was examined after each blow and the interior after the 2 ft 6 in. and 4 ft 6 in. blows. The results of the shock test are given in Table 3.

5. BULGE MEASUREMENTS

The bulge of all sides of the container was measured

- (i) After assembly, with the element and cover, as a cell prior to the shock test.
- (ii) In the assembled condition after the shock test.
- (iii) Unassembled 2 hours after the shock test.

The bulge was obtained by subtracting from the measurements taken in accordance with Section 3(a) at the above stages the measurements taken by Chloride Batteries Ltd., before assembly. The magnitude of the bulge at each stage was as follows:-

TABLE 2

Stage of Test.	Measurements Taken	Bulge (in.) between		
		Horizontal Rib No.	Long sides	Short sides
1	After assembly (before shock test)	2 3	0.381 0.095	0.073 0.087
2	After shock test assembled as cell.	2 3	0.218 0.166	0.188 0.087
3	2 hr. after stage 2 container empty.	2 3	0.098 0.033	0.088 0.009

6. DISCUSSION OF RESULTS

(a) Shock

It will be seen from Table 3 that slight damage occurred at the boundaries of the lower panels and across the lower part of the centre vertical ribs of the long sides at the 2 ft 6 in. blow and that this damage was worsened and extended to other areas by each subsequent blow. After the 4 ft 6 in. blow it was evident that the sub-surface resin along about one quarter of the length of the panel boundaries had sustained slight to moderate damage by the shock test and that the damage to the centre vertical ribs of the two long sides extended below the outer glass fabric. It is considered however that this damage did not materially affect the strength or the serviceability of the container.

(b) Bulge

The method used in this investigation to measure the bulge of the sides gave results that did not take into account the distortion of the corner ribs or other distortions that would have occurred had the container been loaded with the test weight and maintained at a temperature of 57°C for 24 hours as laid down in the specification; and it is considered that the maximum permitted bulge limits stipulated therein would have been exceeded had the test been carried out as specified. The results however are slightly better than those obtained previously on two similar containers, see Report No. 2433/3206/29.

CONCLUSIONS

The experimental thin-panelled homogeneous glass-fibro/resin container Catalogue No. X292, serial No. 2-62 P002 made by Pernali Ltd., has a satisfactory resistance to shock. The bulge of the container measured at laboratory temperature was less than that of the two similar containers tested previously.

THIN-PANELLED GLASS-FIBRE/RESIN CONTAINER MADE BY PERMALI LTD., FOR SUBMARINE CELL TYPE

Results of Shock Test

Blow		Examination	Remarks
No.	Height		
1	2ft 6in.	Exterior	Increase in the opacity of the resin along the boundaries of panels as follows:- A corners BC 3a c and d, and 2a; CD 3La, 2Rb, 1La & 1Rb; DA 2d. In some places in and a few strands of the fabric were slightly proud of the resin. Resin more opaque vertical rib AB from beneath horizontal rib No. 2 $2\frac{1}{2}$ in. towards base, and a number
		Interior	Increase in opacity of resin along boundaries AB 3Lda (1 in.), 3Red (4 in.), 1L and 2 da (5 in.) Resin slightly opaque among 7 in. of vertical fillet A along the base, and at corners CD 2L, 1L & 1Ra and 1R & 2kb. Slight blistering in the opaque less than 0.005 in.)
2	3ft	Exterior	Slight increase in opacity over $\frac{1}{8}$ in. wide area of centre vertical rib between AB corners. Slight increase in opacity over $3/16$ in. wide area of centre vertical rib areas of chamfers at AB 2Lc, 2Rd, 1Ld and 1rd ($2\frac{1}{2}$ in. long); and CD 1Ld (1 in. 1 boundaries AB 3Rd ($2\frac{1}{2}$ in. long); BC 3da (6 in. long), DA 3bc and da ($2\frac{1}{2}$ in. long)
3	3ft 6in.	Exterior	Further slight increase in opacity and very slight lifting of the surface cloth at corners AB 3Rc & 1Rb both $5 \times 5/16 \times 1/64$ in high and along boundary AB 3Red ($2\frac{1}{2}$ in. 3 L & Red, DA 2ab & 3bc (by average of about 2 in.). Increase in opacity of resin few hairline cracks in resin pools along chamfers AB 2L & Red and BC 1ab.
		Interior	Further increase in opacity of resin and slight lifting of the surface cloth along CD 1 & 2Lb and 1 & 2kb $1\frac{1}{2}$ in. to 2 in. towards 1 & 2Lb, and 1 & 2aa. Increase in along boundaries AB 2Lab & CD 3Lda. Increase of opacity of the resin along vertical fillet BC.
4	4ft	Exterior	Further slight increase in opacity of resin across centre vertical rib AB above and across centre vertical rib CD below horizontal rib 2 and some damage to the sub-surface. Narrow wales in outer fabric along boundaries CD 3L da (2 in. long), CD 3ka (1 in. toward d.
5	4ft 6in.	Exterior	Seven narrow bands of opaque resin near top of centre vertical rib AB, short hair particles of surface resin descaled (Figs. 2(a) and 3(a)). Increase in damage to horizontal rib CD2 and a few additional, hairline cracks across centre vertical rib opaque at corners CD1 & 3L. Additional lifting of cloth and pattern more evident $1\frac{1}{2} \times \frac{3}{8} \times 1/64$ in. high). Further slight increase in opacity of resin along boundaries AB & CD 1Rb (typical of such damage) is given in Fig. 2(b) and Fig. 4(a).
		Interior	Further slight increase in opacity of the resin along the panel boundaries and slight surface resin descaled and fibres loosened and fluffed out along boundaries AB 1Rc (Fig. 4(b) and 3Lda. Between 10% and 40% of the fibres ruptured in the small area (Fig. 4(c)); CD 1L & Rb. Resin opaque and pattern of weave slightly raised also

Note 1. The identification of the parts of the container and the abbreviations used are shown

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TABLE 3

CONTAINER MADE BY PERMALI LTD., FOR SUBMARINE CELL TYPE 8000 - SHOCK

Results of Shock Test

Remarks

the resin along the boundaries of panels as follows:- AB 3Red and 1Rab (2 in.); DA 3ad and bc (2½ in.) and at 12a; CD 3La, 2Rb, 1La & 1Rb; DA 2d. In some places in these opaque areas the pattern of the outer fabric was clear. Fabric were slightly proud of the resin. Resin more opaque and a number of hairline cracks in both chamfers of centre with horizontal rib 1c. 2 2½ in. towards base, and a number of hairline cracks similarly placed on side CD.

Resin along boundaries AB 3Lda (1 in.), 3Red (4 in.), 1L and 1Rab (6 in.); BC 3ad (2 in.), 2da (3 in.); DA 3bc (2½ in.) lightly opaque among 7 in. of vertical fillet A, along three 2 in. lengths of vertical fillet B - all within 12 in. of 1, 1L & 1Ra and 1R & 2kb. Slight blistering in the opaque corner areas of panels of side CD - outer fabric raised

over 7 in. wide area of centre vertical rib between AB 2Lc & 2kd and a total of 4 deep hairline cracks at these in opacity over 3/16 in. wide area of centre vertical rib between CD 2Lc and 2kd. Hairline cracks in resin-rich 1c, 2kd, 1Lc and 1L (2 in. long); and CD 1Ld (2 in. long). Increase in opacity of resin over narrow areas at 1c; BC 3da (6 in. long), DA 3bc and da (2½ in. long) and at corners AB 3La, 3Rc and BC 3a.

opacity and very slight lifting of the surface cloth along boundaries AB 1Rab; CD 1,2 and 3La and 1 & 2Rb. Sale in 5 x 5/16 x 1/64 in high and along boundary AB 3Red (2½ in. Long). Extension of opaque areas along boundaries AB by average of about 2 in.). Increase in opacity of resin at corner BC 1b and from corner DA 3c - 3 in. towards b. A resin pools along chamfers AB 2L & Red and BC 1ab.

ty of resin and slight lifting of the surface cloth along boundaries AB 3Lda, 3Red, 1L & Rab and from corners 1 in. to 2 in. towards 1 & 2Lb, and 1 & 2ka. Increase in opacity of resin and slight lifting of the surface cloth & CD 3Lda. Increase of opacity of the resin along vertical fillets A & B 10 in. upwards from base and along base

a opacity of resin across centre vertical rib AB above and below horizontal rib 2. A few additional hairline cracks b CD below horizontal rib 2 and some damage to the sub-surface resin (probably to its bond with the outer glass cloth). ric along boundaries CD 3L da (2 in. long), CD 3ka (1 in long). Narrow areas of opaque resin from corner CD 1Rc 2 in.

ue resin near top of centre vertical rib AB, short hairline cracks along the middle area of these bands and a few a descaled (Figs. 2(a) and 3(a)). Increase in damage to sub-surface resin of centre vertical rib CD below few additional, hairline cracks across centre vertical rib above horizontal rib CD3. Small areas of surface resin L. Additional lifting of cloth and pattern more evident at wales at these corners and at CD1 & 2Rb (all wales about Further slight increase in opacity of resin along boundaries of panels of side BC. Views of the damage at corners uch damage) is given in Fig. 2(b) and Fig. 4(a).

a opacity of the resin along the panel boundaries and slight enlargement of the wales at AB 1 & 2Lab, 3La and 3R cd. d fibres loosened and fluffed out along boundaries AB 1Rab, 2Lab, 3Lda and 3Red (Fig. 3(b)); CD1L & Rab, 2L&Rab n 10% and 40% of the fibres ruptured in the small areas of exposed fibres along boundaries AB 2Lab, 3Lda, 3Red, b. Resin opaque and pattern of weave slightly raised along boundaries DA2 ab, DA3bc & da.

parts of the container and the abbreviations used are shown in Fig. 1.

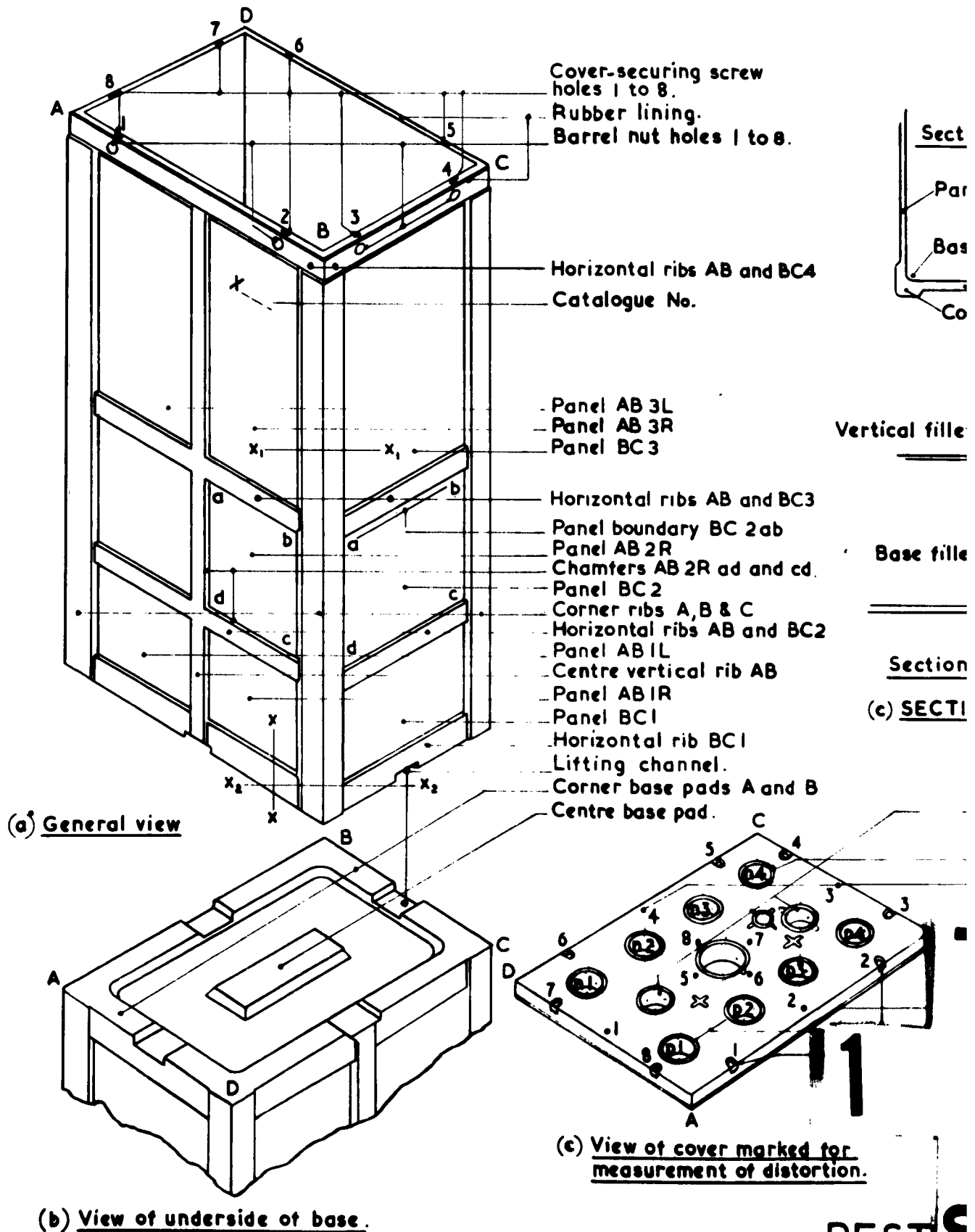
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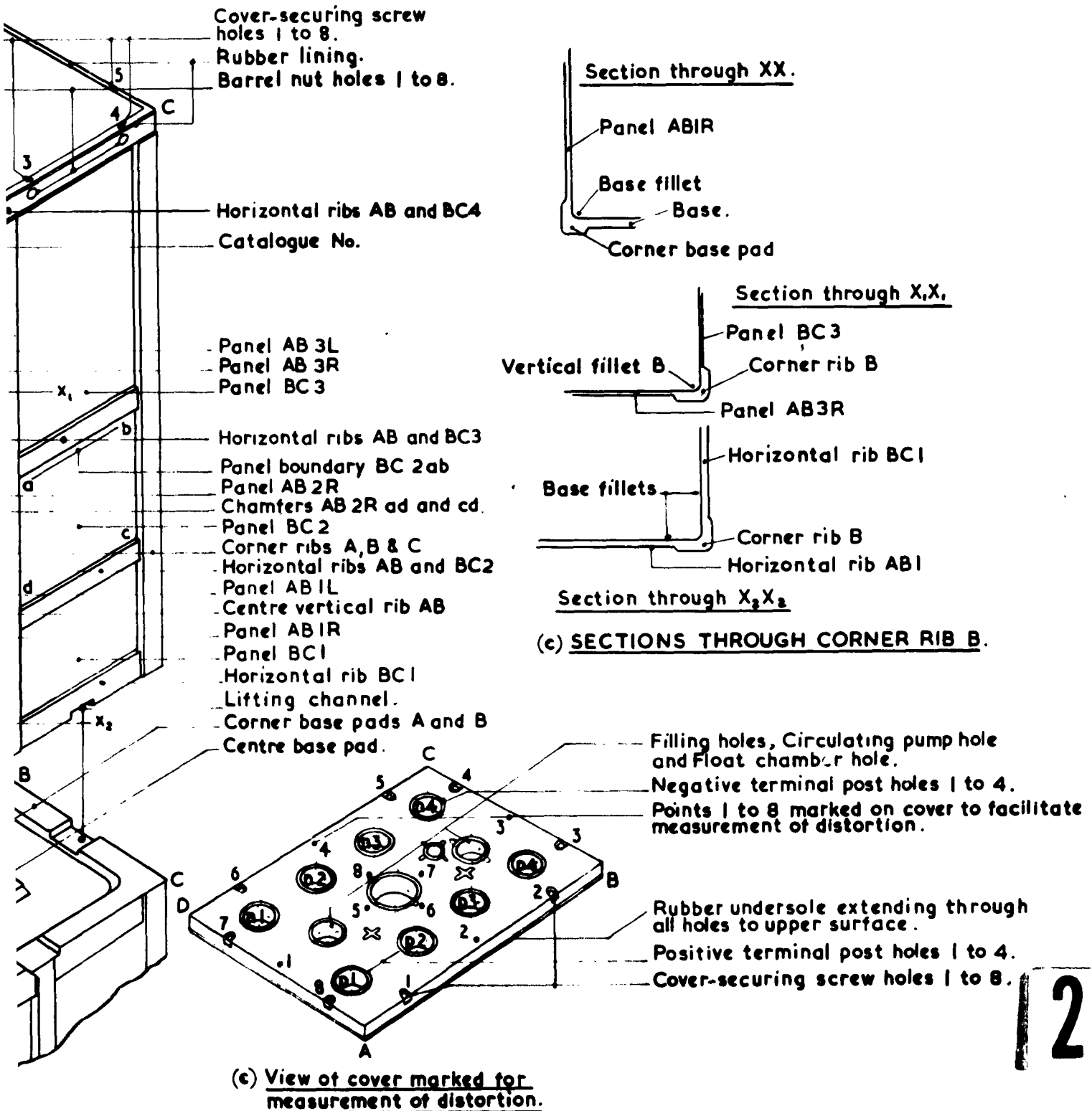
EXPERIMENTAL THIN-PANELLED GLASS-FIBRE/RESIN CONTAINERS MADE FOR SUBMARINE CELL TYPE 8000 - SHC

PARTS OF CONTAINER AND COVER.



GLASS-FIBRE/RESIN CONTAINERS MADE BY PERMALI LTD. AND U.E.L. LTD. FOR SUBMARINE CELL TYPE 8000 - SHOCK.

PARTS OF CONTAINER AND COVER.

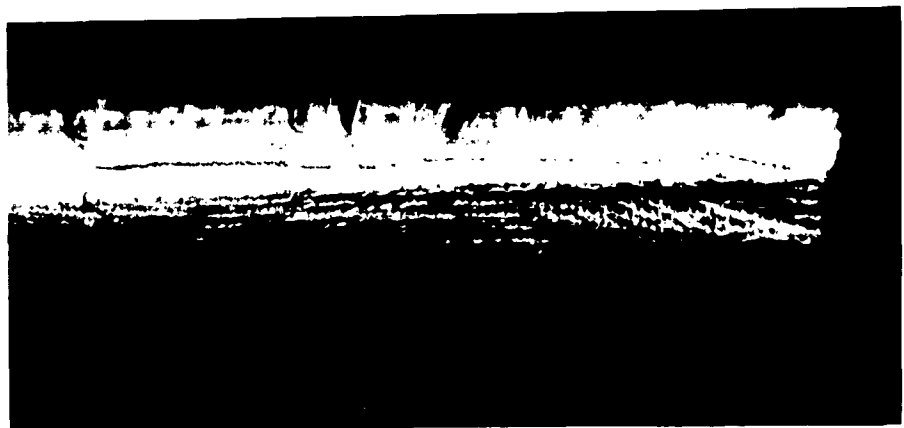


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THIN-PANELLED GLASS-FIBRE/RESIN CONTAINER MADE BY PERMALI LTD. FOR
SUBMARINE CELL TYPE 8000 - SHOCK.



(a) Container after the shock test showing damage to centre vertical rib AB and to the boundaries of the panels.

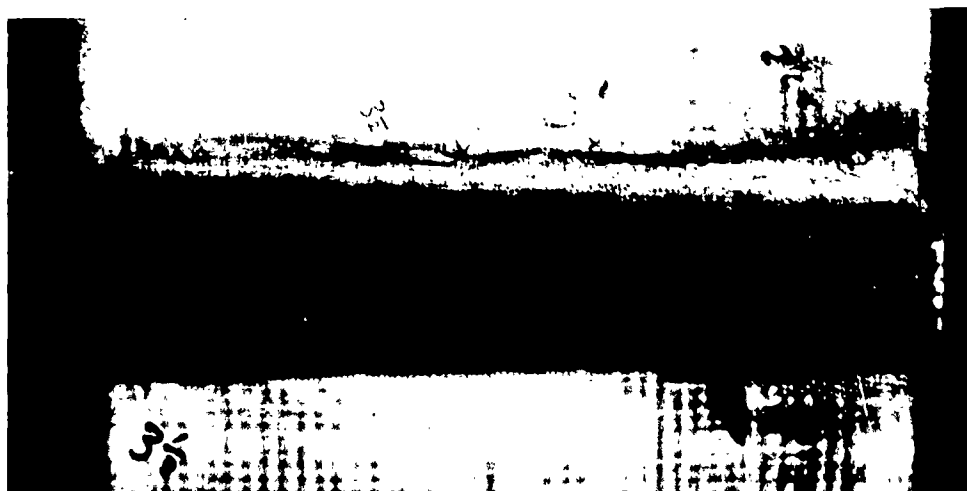


(b) Wale below chamfer AB1Rab showing ridge in outer cloth.

THIN-PANELLED GLASS-FIBRE/RESIN CONTAINER MADE BY PERMALI LTD. FOR
SUBMARINE CELL TYPE 8000 - SHOCK.



(a) Damage to resin of centre vertical rib AB below
horizontal rib 2 (container illuminated from inside).



(b) Damage to AB3Rod (container illuminated from inside).

THIN-PANELLED GLASS-FIBRE/RESIN CONTAINER MADE BY PERMALI LTD. FOR SUBMARINE
CELL TYPE 8000 - SHOCK.

Views showing damage to the container as a result of
the shock test.



(a) Wale at corner CD1Rb. Note ridge and raised pattern of cloth.



(b) Damage at boundary CD2Rb.



(c) Damage at boundary AB3Red.

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